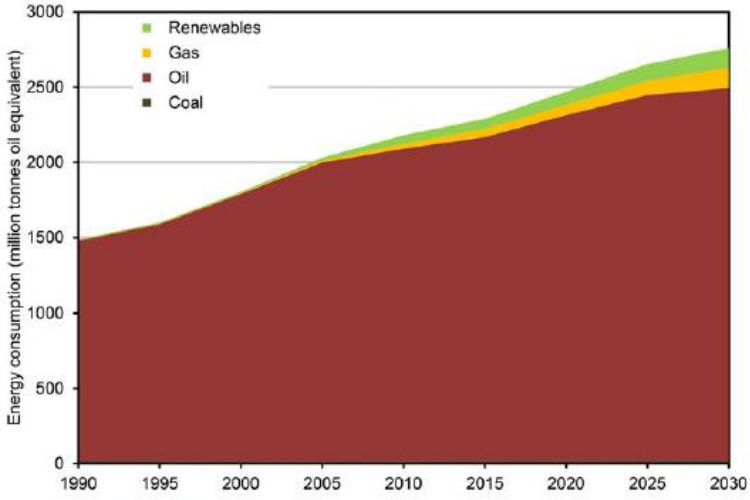


Fig. 23.2 World energy consumption for the transport sector.

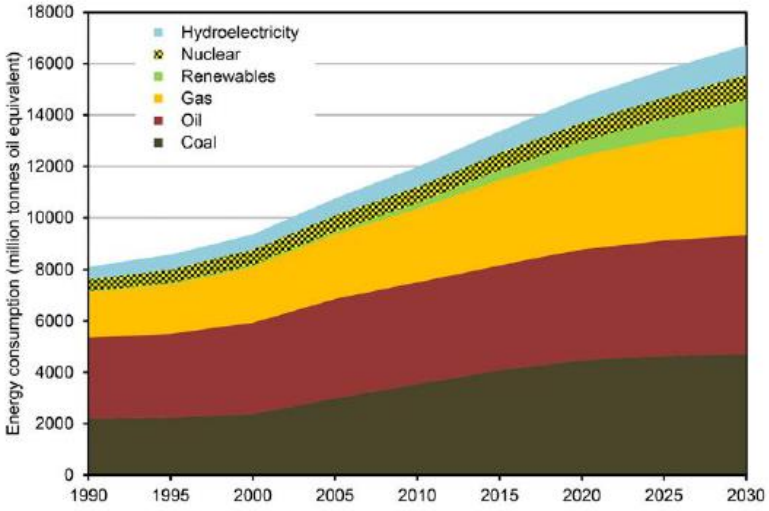
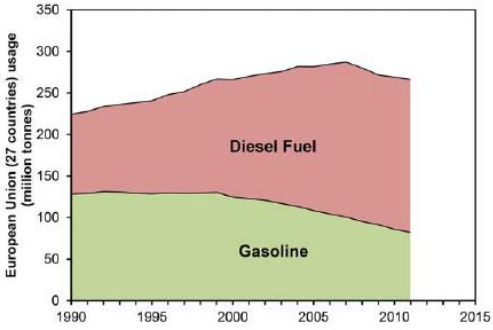


Fig. 23.1 World energy consumption by source.



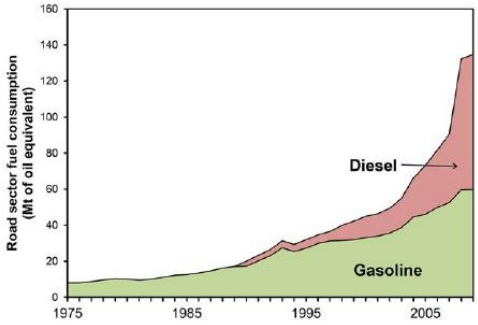


Fig. 1.5 Chinese road sector fuel consumption.

Table 3.1 Yield (wt %) of Main Products from Crude Oil by Distillation

Crude Type	Arabian Light	Nigerian	Brent	Maya
LPG	0.7	0.6	2.1	1.0
Naphtha	17.8	12.9	17.8	11.7
Gas oil/Kerosene	33.1	47.2	35.5	23.1
Residue	48.4	39.3	44.6	64.2

Manufacture of Gasoline and Diesel Fuel from Crude Oil

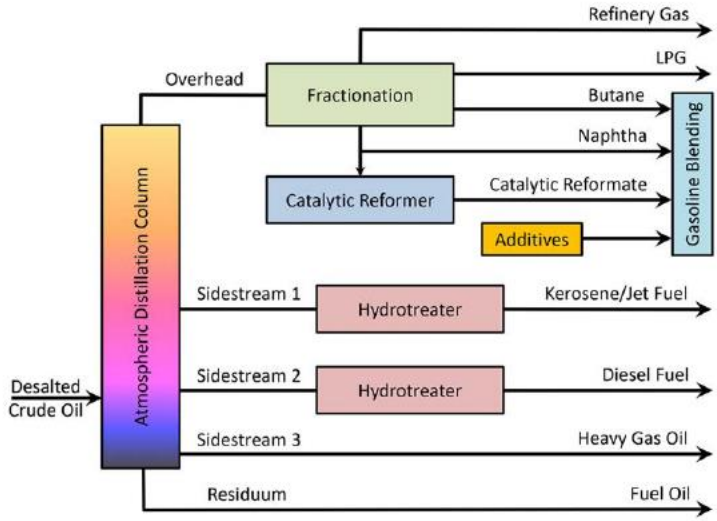


Fig. 3.1 Simplified flow diagram of a hydroskimming refinery.

Manufacture of Gasoline and Diesel Fuel from Crude Oil

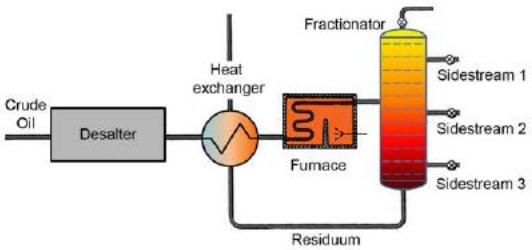


Fig. 3.4 Flow through a pipestill.

Fig. 3.5 Atmospheric and vacuum distillation units.

Table 4.2 Properties of the Main Hydrocarbon Fuel Gases

	Methane	Ethane	Propane	Propene	n-Butane	iso-Butane	Butenes
Energy Content (LHV) (MJ/kg)	50.01	47.48	46.35	45.78	45.74	45.59	45.32
Liquid density (kg/L)	0.466	0.572	0.501	0.519	0.601	0.549	0.607
Liquid energy Density (MJ/L)	23.30	27.16	23.22	23.76	27.49	25.03	27.51
Gas energy density (MJ/m^3)	32.6	58.4	84.4	79.4	111.4	110.4	113.0
Gas specific gravity (@ 25 °C)	0.55	1.05	1.55	1.47	2.07	2.06	1.93
Boiling point, °C	-164	-89	-42	-47	-0.5	-12	-6.3 to 3.7
Research octane No.	> 127	—	109	—	—	—	—
Motor octane No.	122	101	96	84	89	97	77
Wobbe index (MJ/m^3)	50.66	65.11	74.54	71.97	85.46	84.71	81.27

Table 4.3 Range of LPG Composition for Different Countries

Country	Propane and Propene (%)
Belgium	40–60
Chile: commercial propane commercial butane	 70–100 0–30
Finland	100
France	20–50
Germany	100
Netherlands	30–70
United Kingdom	50–100
United States	98–100

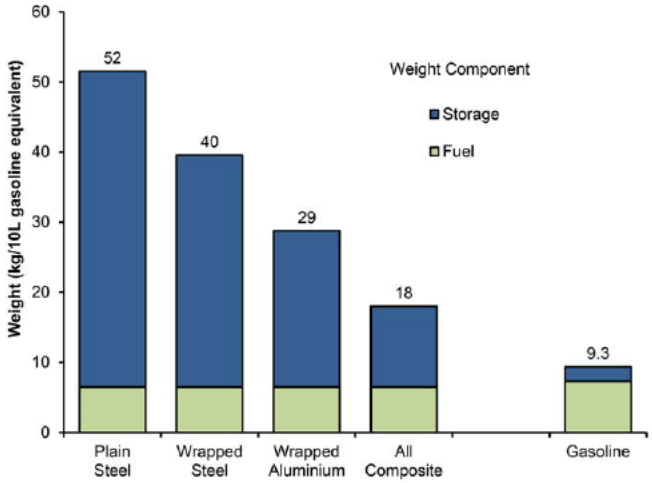


Fig. 4.11 Comparison of fuel and storage system weights for CNG and gasoline.

Table 7.1 Properties of Iso-octane and n-Heptane

Property	Iso-octane	n-heptane
Density (kg/m3 @ 25 °C)	0.69	0.68
Boiling point (°C)	99–100	98–99
Vapor pressure (kPa @ 25 °C)	5.5	5.3
Flammability limits (% in air)	1–6	1–7

Table 7.2 Test Conditions for the Research and Motor Test Procedures

Test	Research	Motor
CRC designation	F-1	F-2
ASTM method	D2699	D2700
Engine speed, rpm	600	900
Intake air temperature, °C	depends on barometric pressure	38
Mixture temperature, °C	not specified	149
Coolant temperature, °C	100	100
Ignition advance, deg. BTDC	13	linked to compression ratio

Benzinin Özellikleri

Kurşun miktarının azaltılması

TEL

Oksijen miktarının ayarlanması

CO, HC azalıyor , Aldehitler artıyor (kansorejen, fotokimyasal etki)

Aromatik miktarının azaltılması

NOx artıyor , benzen (C6H6) azalıyor (kansorejen)

Benzen miktarının azaltılması

Olefin miktarının azaltılması

1.3 butadiene emisyonları

Kükürt miktarının azaltılması

Katalitik dönüştürücülere etkin, ilk hareket ve ısınma süresinde özellikle

Table 7.6 Approximate Octane Blending Values

	Blending RON	Blending MON
Methanol	127–136	99–104
Ethanol	120–135	100–106
Tert. butanol	104–110	90–98
Methanol/TBA 50/50	115–123	96–104
MTBE	115–123	98–105
TAME	111–116	98–103
ETBE	110–119	95–104

Benzinin Özellikleri

Buhar basıncının düzenlenmesi

Reid buhar basıncının azalması evaporatif emisyonları azaltıyor

Distilasyon eğrisinin ayarlanması

Orta bölüm + HC ve CO azalıyor, NOx artıyor

Üst bölüm + HC azalıyor, CO ve NOx artıyor

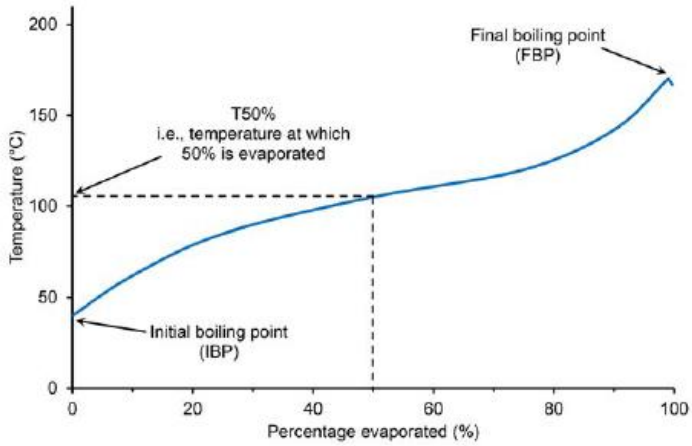


Fig. 9.7 ASTM D86 distillation curve.

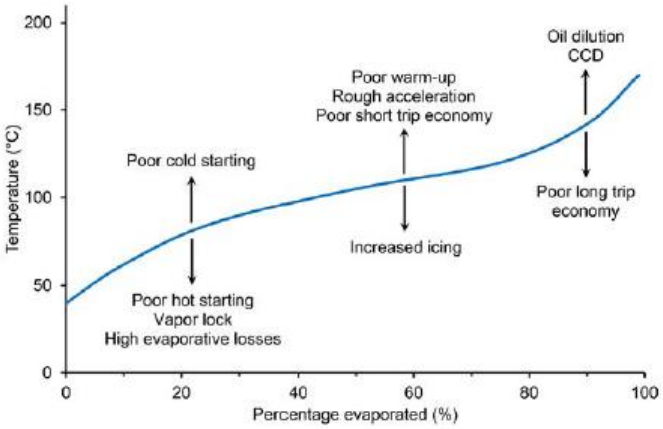


Fig. 9.3 Gasoline volatility is a compromise.

Katkı maddelerinin düzenlenmesi

Deterjanlar depozitleri artırıyor

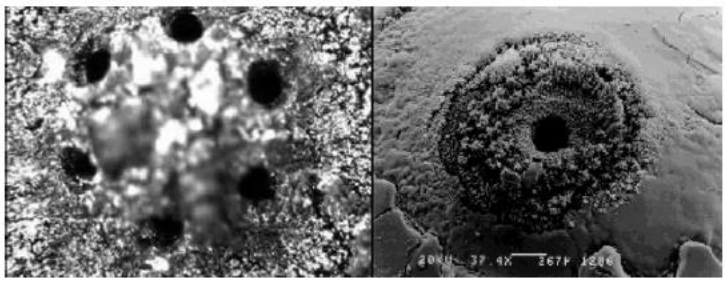


Fig. 10.7 Direct injection spark ignition fuel injectors showing deposit build-up.

Table 1. Impact of various gasoline fuel properties and emissions at different levels of vehicle technology. [35]

Gasoline	No Catalyst	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5/6[3]	Comments
Lead ↑	Pb, HC↑	CO, HC, NO_x all increase dramatically as catalyst destroyed					Lead is banned in China gasoline since 2000
Sulfur ↑ (50 to 450 ppm)	SO_2 ↑	CO, HC, NO_x all increase ~15-20% SO_2 and SO_3 increase					Onboard Diagnostic light may come on incorrectly
Olefins ↑	Increased 1,3 butadiene, increased HC reactivity, NO_x, small increases in HC for Euro 3 and cleaner						Potential deposit buildup
Aromatics ↑	Increased benzene in exhaust						Deposits on intake valves and combustion chamber tend to increase
	Potential increases in HC, NO_x	HC↑, NO_x↓, CO↑		HC, NO_x, CO ↑			
Benzene ↑	Increased benzene exhaust and evaporative emissions						
Ethanol ↑ up to 3.5% O_2	Lower CO, HC, slight NO_x increase(when above 2% oxygen content), Higher aldehydes	Minimal effect with new vehicles equipped with oxygen sensors, adaptive learning systems					Increased evaporative emissions unless RVP adjusted, potential effects on fuel system components, potential deposit issues, small fuel economy penalty
MTBE ↑ up to 2.7% O_2	Lower CO, HC, higher aldehydes	Minimal effect with new vehicles equipped with oxygen sensors, adaptive learning systems					Concerns over water contamination
Distillation Characteristics T50, T90↑	Probably HC↑	HC↑					
MMT ↑	Increased Manganese Emissions			Possible Catalyst Plugging	Likely Catalyst Plugging		O_2 sensor and OBD may be damaged, MIL light may come on incorrectly
RVP ↑	Increased evaporative HC Emissions						Most critical parameter for Asian countries because of high ambient Temperatures
Deposit control additives ↑		Potential HC, NO_x emissions benefits					Help to reduce deposits on fuel injectors, carburetors, intake valves, combustion chamber

Gasoline specifications—recommended limits

Property	Units		Category 1	Category 2	Category 3	Category 4	Category 5
'91 RON[1]	RON	min	91	91	91	91	
	MON	min	82	82.5	82.5	82.5	
'95 RON[1]	RON	min	95	95	95	95	95
	MON	min	85	85	85	85	85
'98 RON[1]	RON	min	98	98	98	98	98
	MON	min	88	88	88	88	88
Oxidation stability	minutes	min	360	480	480	480	480
Sulfur	mg/kg	max	1000	150	30	10	10
Trace metals[2]	mg/kg	max	1 or non-detectable, whichever is lower				
Oxygen[3]	% m/m	max	2.7[4]	2.7[4]	2.7[4]	2.7[4]	2.7[4]
Olefins	% v/v	max		18.0	10.0	10.0	10.0
Aromatics	% v/v	max	50.0	40.0	35.0	35.0	35.0
Benzene	% v/v	max	5.0	2.5	1.0	1.0	1.0
Volatility							
Sediment	mg/l	max		1	1	1	1
Unwashed gums	mg/100 ml	max	70	70	30	30	30
Washed gums	mg/100 ml	max	5	5	5	5	5
Density	kg/m^3	min	715	715	715	715	720
		max	780	770	770	770	775
Copper corrosion	rating	min	Class 1	Class 1	Class 1	Class 1	Class 1
Silver corrosion	rating	min				Class 1	Class 1
Appearance			Clear and bright; no free water or particulates				
Carburetor cleanliness	merit	min	8.0				
Fuel injector cleanliness, Method 1	% flow loss	max	10[5]	5	5	5	5
Fuel injector cleanliness, Method 2	% flow loss	max	10[5]	10	10	10	10
Particulate contamination size distribution	Code rating no. of particles/ml				18/16/13 per ISO 4406		
Intake valve sticking	pass/fail			Pass	Pass	Pass	Pass

Diesel Yakıtının Özellikleri

Cetane sayısı

tutuşma kalitesi

Yoğunluk

performans, tutuşma, güç, tüketim, düşük T özelliklerine etkin

Viskozite

akıcılık

Düşük sıcaklık özellikleri

solubilite, wax oluşumu, akıcılık

Diesel Yakıtının Özellikleri

Yakıtın stabilitesi

üretimden kullanıma özelliklerini koruması, tortu oluşumu

kimyasal reaksiyonlar, serbest radikallerin oluşumu

gum oluşumu

Kükürt miktarı

motorda aşınma (piston, segmanlar), partikül

Aromatikler

partikül madde emisyonu artıyor

Fig. 10.4 Intake valves from different CEC F-05-A-93 tests. (Source: APL Automobil-Prüftechnik Landau GmbH.)

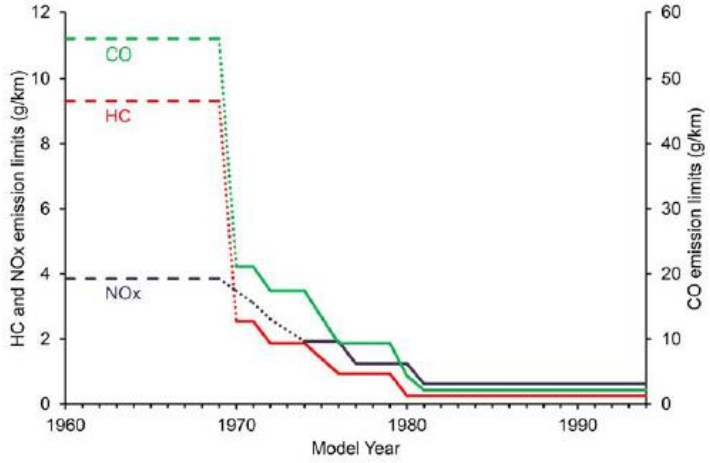


Fig. 13.1 Evolution of U.S. emissions limits until 1994.

Table 13.2 Evolution of EU Emissions Limits

		Emissions Limit (g/km)						
	Year	CO	HC	NMHC	HC + NO_x	NO_x	PM	PN (\km)
Euro 1	1992	2.72	—	—	0.97	—	0.140	—
Euro 2	1996	2.2	—	—	0.50	—	—	—
Euro 3	2000	2.3	0.20	—	—	0.15	—	—
Euro 4	2005	1.0	0.10	—	—	0.08	—	—
Euro 5	2009	1.0	0.10	0.068	—	0.06	0.005	—
Euro 6	2014	1.0	0.10	0.068	—	0.06	0.005	6.0 E^{11}

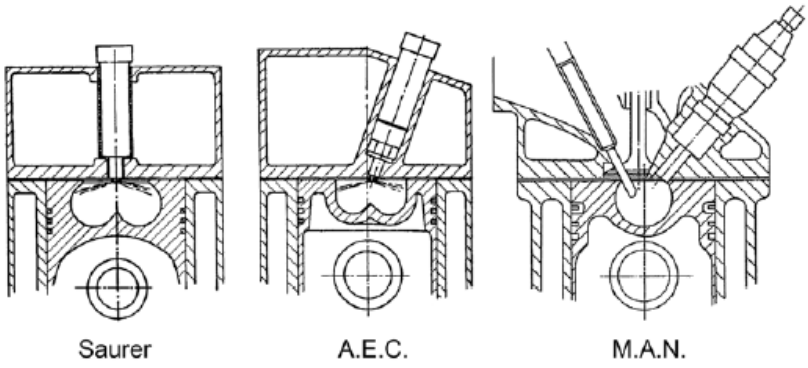


Fig.16.2 Various bowl in piston configurations for DI combustion chambers.

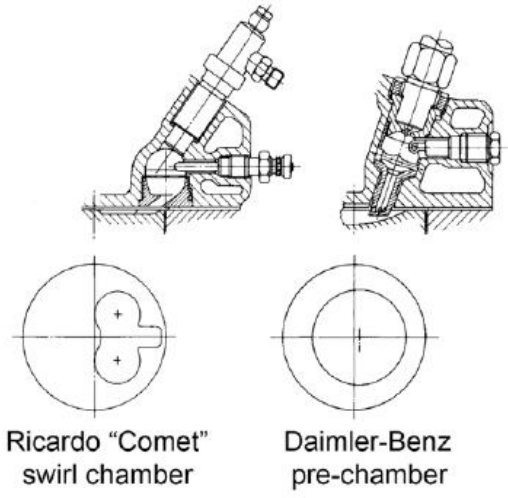


Fig. 16.3 Divided chamber configurations.

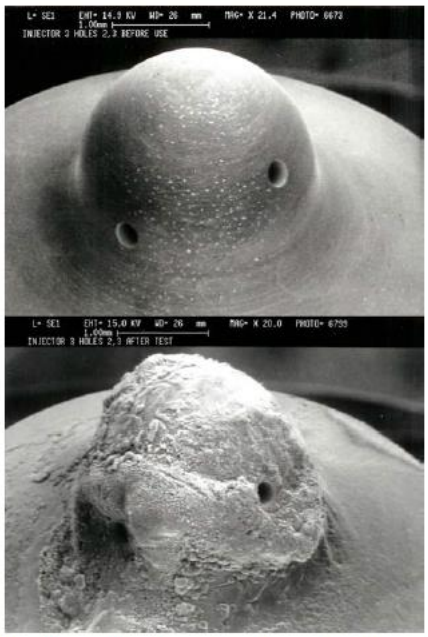


Fig. 18.10 Clean (above) and fouled (below) injector tip after 1.5 hours running.

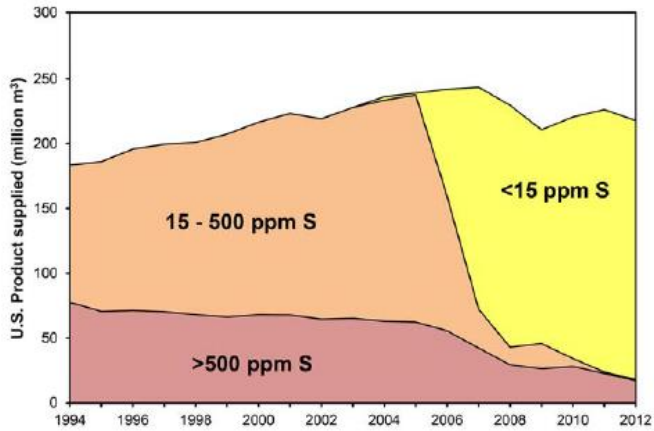


Fig. 1.4 Sulfur content of U.S. supplied diesel fuel.

Diesel fuel specifications—recommended limits

Property	Units		Category 1	Category 2	Category 3	Category 4	Category 5
Cetane number		min	48.0	51.0	53.0	55.0	55.0
Cetane index[1]		min	48.0 (45.0)	51.0 (48.0)	53.0 (50.0)	55.0 (52.0)	55.0 (52.0)
Density @ 15 °C	kg/m³	min max	820[2] 860	820[2] 850	820[2] 840	820[2] 840	820[2] 840
Viscosity @ 40 °C	mm²/s	min max	2.0[3] 4.5	2.0[3] 4.0	2.0[3] 4.0	2.0[3] 4.0	2.0[3] 4.0
Sulfur content	mg/kg	max	2000	300	50	10	10
Trace metal content[4]	mg/kg	max		1 or non-detectable, whichever is lower			
Total aromatic content	% m/m	max		25	20	15	15
PAH (di+, tri+)	% m/m	max		5	3.0	2.0	2.0
T90	°C	max		340[5]	320[5]	320[5]	320[5]
T95	°C	max	370	355[5]	340[5]	340[5]	340[5]
Final boiling point	°C	max		365	350	350	350
Flash point	°C	min	55[6]	55	55	55	55
Carbon residue	% m/m	max	0.30	0.30	0.20	0.20	0.20
CFPP or LFTT or CP	°C	max	At least 5 °C lower than the lowest expected ambient temperature.[7]				
Water content	mg/kg	max	500	200	200	200	200
Oxidation stability, Method 1	g/m³	max	25	25	25	25	25
Oxidation stability, Method 2	hours	min	30	35	35	35	
Oxidation stability, Method 3 (Delta TAN)	mg KOH/g	max	0.12[8]	0.12[8]	0.12[8]	0.12[8]	0.12
Foam volume	ml				100	100	100
Foam vanishing time	sec.				15	15	15
Biological growth				"Zero" content			
FAME content	% v/v	max	5[9]	5[9]	5[9]	5[9]	non-detectable
Other biofuels[10]	% v/v	max					
Ethanol/Methanol	% v/v	max	Non-detectable[11]				
Total acid number	mg KOH/g			0.08	0.08	0.08	0.08
Ferrous corrosion				Light rusting			